WHAT IS CLAIMED IS:

1.   A method of fractionation of a mixture of particles comprising:
         providing a first electrode positioned in the first plane and a second
electrode positioned in a second plane different from the first plane, an electrolyte
5   solution located therebetween and a plurality of particles suspended at an interface
between the electrolyte solution and the second electrode, wherein the second
electrode comprises a planar electrode having a surface and an interior, the surface
or the interior having been patterned to modify the spatial distribution of the
interfacial electric field, and wherein the particles comprise at least two types of
10   particles, each particle type having a distinguishable relaxation frequency; and
         generating an electric field between the first and the second electrode
by applying an AC voltage between the two electrodes, said electric field having a
frequency that is less than or equal to the relaxation frequency of at least one of said
particle types but greater than the relaxation frequencies of other particle types,
15   wherein the electric field in combination with the patterning of the electrode
produces fractionation of the particles having relaxation frequencies greater than or
equal to the frequency of the electric field from other particles.

2.   The method according to claim 1, wherein the electrode is patterned
by spatially modulated oxide growth, surface chemical patterning or surface
20   profiling.

3.   The method according to claim 1, wherein the particle relaxation
frequency reflects the particle size, such that the particles are fractionated based on
the particle size.

4.   The method according to claim 1, wherein the particle relaxation
25   frequency reflects the surface composition of the particles, such that the particles are
fractionated based on the properties of said surface composition.

5.   The method according to claim 1, wherein the generation of the
electric field results in formation of a planar array of substantially one layer of
particles in a designated area on the second electrode, said designated area being
30   defined by the spatial modulation affecting local distribution of the electric field at

the surface of the second electrode, the particles of said array having the relaxation frequencies greater than or equal to the frequency of the electric field.

6.   The method of claim 1, wherein the second electrode comprises a silicon electrode which is coated with a dielectric layer.

7.   The method of claim 1, wherein the frequency of the electric field is from 120 Hz to 100 kHz.

8.   The method of claim 1, wherein the first electrode comprises an optically transparent electrode, the method further comprising monitoring the fractionation of the particles using a video detector or camera.

9.   The method of claim 1, wherein the particle mixture comprises two types of particles, such that the electric field in combination with the electrode patterning results in fractionation of one type of particles from another, with the particles having the relaxation frequencies greater than or equal to the frequency of the electric field assembling in a planar array in the area on the second electrode designated by the spatial modulation affecting local distribution of the electric field at the surface of the second electrode.

10.   The method of claim 1, wherein the particle mixtures comprise more than two types of particles, and the particles are fractionated one particle type at a time by adjusting the frequency to allow sequential fractionation of one type of particles at a time.

11.   The method of claim 1, wherein the particles comprise eukaryotic or procaryotic cells.

12.   The method of claim 11, wherein the combination of the electric field and the illumination results in formation of a planar assembly of substantially one layer of cells in a designated area of the electrode defined by the patterning of the electrode, the relaxation frequencies of the particles in said assembly being greater than or equal to the frequency of the electric field.

13.   The method of claim 1, wherein the second electrode comprises a light-sensitive electrode, the method further comprising illuminating the interface with a predetermined light pattern, said illumination in combination with the electric field and the electrode patterning resulting in fractionation of particles.

5   14.   The method of claim 13, wherein the predetermined light pattern is provided by an apparatus for programmably generating and imaging onto a substrate an illumination pattern having a predetermined arrangement of light and dark zones, said apparatus comprising:

an illumination source;

10   a reconfigurable mask composed of an array of pixels, said pixels being actively controllable and directly addressable by means of a computer-controlled circuit and computer interface, said computer-controlled circuit being operated using a software program providing temporal control of the intensity of illumination emanating from each pixel so as to form the illumination pattern

15   comprising the predetermined arrangement of light and dark zones;

a projection system suitable for imaging the reconfigurable mask onto the substrate; and

an imaging system incorporating a camera capable of viewing said substrate with superimposed illumination pattern.

20   15.   A method of determining the zeta potential of particles suspended in an electrolyte solution and/or the mobility of ions or molecules within a region adjacent to said particles, the method comprising:

providing a plurality of particles having a characteristic relaxation frequency suspended at an interface between an electrolyte solution and a light-

25   sensitive electrode;

illuminating the interface with a predetermined light pattern;

generating an electric field at the interface by application of an AC voltage, said electric field having a frequency, and adjusting the frequency of said electric field to form a planar array of substantially one layer of particles in a

30   designated area on the electrode defined by the pattern of illumination, wherein said

interface exhibits impedance gradients when subjected to the electric field and the illumination;

determining the relaxation frequency of said particles;

determining maximal velocity (vmax) of said particles; and

converting the maximal velocity and the relaxation frequency to the zeta potential and/or surface conductivity of said particles.

16. The method of claim 15, wherein the surface potential and the surface conductivity of the particles are determined simultaneously.

17. The method of claim 15, in which the relaxation frequency of the particles are determined by measuring the frequency of the electric field at which the array is formed.

18. The method of claim 15, further comprising the step of altering the configuration of the assembly after its formation by adjusting the frequency of the electric field, and measuring the frequency of the electric field that is associated with alteration of the array configuration.

19. The method of claim 15, in which the maximal velocity is determined by measuring the velocities of the particles crossing impedance gradients in the course of array assembly.

20. The method of claim 15, in which the maximal velocity of the particles are determined by means of image analysis and particle tracking.

21. The method of claim 15, wherein the maximal velocity and the relaxation frequency of the particles are converted to the surface potential and the surface conductivity by applying the numerical modeling procedure set forth in Fig. 5.

22. The method of claim 15, wherein the electrode comprises a silicon electrode which is coated with a dielectric layer.

23. The method of claim 15, further comprising an additional electrode, wherein the additional electrode and the light-sensitive electrode are substantially

planar and parallel to one another and separated by a gap, with the electrolyte solution containing the particles being located in the gap, and wherein the electric field is generated by applying an AC voltage between the two electrodes.

24. The method of claim 15, wherein the method determines the zeta potential of the particles.

25. The method of claim 15, wherein the method determines the mobility of ions or molecules within a region adjacent to the particles.

26. A method of determining the zeta potential of particles suspended within an electrolyte solution and/or the mobility of ions or molecules within a region adjacent to said particles, the method comprising:

provilding a first electrode positioned in the first plane and a second electrode positioned in a second plane different from the first plane, an electrolyte solution located therebetween and a plurality of particles of one or more types, each type having a characteristic relaxation frequency, said particles being suspended at an interface between the electrolyte solution and the second electrode, wherein the second electrode comprises a planar electrode having a surface and an interior, the surface or the interior having been patterned to modify the spatial distribution of the interfacial electric field;

generating an electric field between the first and the second electrode by applying an AC voltage between the two electrodes, said electric field having a frequency;

adjusting the frequency of said electric field to produce particle transport into a designated area of the electrode defined by said patterning of the electrode;

determining relaxation frequencies of said one or more types of particles;

determining maximal velocity (vmax) of transport of said particles; and

converting said relaxation frequency and said maximal velocity to the zeta potential of said particles and/or mobility of ions or molecules within a region adjacent to said particles.

27.   The method of claim 26, wherein the surface potential and the surface conductivity of the particles are determined simultaneously.

28.   The method of claim 26, in which the relaxation frequency of the particles are determined by measuring the frequency of the electric field at which the array is formed.

29.   The method of claim 26, further comprising the step of altering the configuration of the assembly after its formation by adjusting the frequency of the electric field, and measuring the frequency of the electric field that is associated with alteration of the array configuration.

30.   The method of claim 26, in which the maximal velocity is determined by measuring the velocities of the particles crossing impedance gradients in the course of array assembly.

31.   The method of claim 26, in which the maximal velocity of the particles are determined by means of image analysis and particle tracking.

32.   The method of claim 26, wherein the maximal velocity and the relaxation frequency of the particles are converted to the surface potential and the surface conductivity by applying the numerical modeling procedure set forth in Fig. 5.

33.   The method of claim 26, wherein the electrode comprises a silicon electrode which is coated with a dielectric layer.

34.   The method of claim 26, wherein the method determines the zeta potential of the particles.

35.   The method of claim 26, wherein the method determines the mobility of ions or molecules within a region adjacent to the particles.